

What is claimed is:

1. A fabrication method of a semiconductor integrated circuit device, comprising:

a first step of depositing a cobalt film over the main surface of a silicon substrate; and

a second step of heat treating the silicon substrate to form a silicide layer on the interface between the silicon substrate and the cobalt film,

wherein in the first step, the cobalt film is deposited at a temperature lower than a temperature at which a reaction layer of silicon and cobalt is formed on the interface between the silicon substrate and the cobalt film.

2. A fabrication method of a semiconductor integrated circuit device according to Claim 1,

wherein the cobalt film is deposited at a temperature less than 200°C.

3. A fabrication method of a semiconductor integrated circuit device according to Claim 2,

wherein the cobalt film is deposited at a temperature less than 100°C.

4. A fabrication method of a semiconductor integrated circuit device according to Claim 3,

wherein the cobalt film is deposited at a temperature less than 50°C.

5. A fabrication method of a semiconductor integrated circuit device according to Claim 1,

wherein the heat treatment of the silicon substrate in the second step comprises the steps of:

(a) a first heat treatment for forming a silicide layer having, as a main component, dicobalt silicide ( $\text{Co}_2\text{Si}$ ) on the interface between the silicon substrate and the cobalt film;

(b) a second-stage heat treatment for converting the main component of the silicide layer from dicobalt silicide into cobalt monosilicide ( $\text{CoSi}$ ); and

(c) a third-stage heat treatment for removing an unreacted portion of the cobalt film from the main surface of the silicon substrate and converting the main component of the silicide layer from cobalt monosilicide to cobalt disilicide ( $\text{CoSi}_2$ ).

6. A fabrication method of a semiconductor integrated circuit device according to Claim 5,

wherein the temperature of the first-stage heat treatment falls within a range of  $200^\circ\text{C}$  or greater but less than  $400^\circ\text{C}$ , the temperature of the second-stage heat treatment falls within a range of  $400^\circ\text{C}$  or greater but less than  $700^\circ\text{C}$ , and the temperature of the third-stage heat treatment falls within a range of  $700^\circ\text{C}$  or greater but less than  $900^\circ\text{C}$ .

7. A fabrication method of a semiconductor integrated circuit device according to Claim 1, further comprising, between the first and second steps, a step of depositing an oxidation barrier film over the cobalt film.

8. A fabrication method of a semiconductor integrated circuit device, comprising the steps of:

(a) depositing a cobalt film over the main surface of a silicon wafer in a first sputtering chamber of a sputtering apparatus equipped with a plurality of chambers including at least a sputtering chamber and a heat treatment chamber;

(b) depositing, in a second sputtering chamber of the sputtering apparatus, an oxidation barrier film over the main surface of the silicon wafer having the cobalt film deposited thereover;

(c) forming, in the second sputtering chamber, a silicide layer having dicobalt silicide ( $\text{Co}_2\text{Si}$ ) as a main component over the interface between the silicon wafer and the cobalt film by a first-stage heat treatment in which the silicon wafer having the oxidation barrier film deposited thereover is heated;

(d) after the step (c), converting the main component of the silicide layer from dicobalt silicide to cobalt monosilicide ( $\text{CoSi}$ ) by a second-stage heat treatment in which the silicon wafer is heated at a temperature higher

than the temperature of the first-stage heat treatment;

(e) after the step (d), removing the oxidation barrier film and an unreacted portion of the cobalt film from the main surface of the silicon wafer; and

(f) after the step (e), converting the main component of the silicide layer from the cobalt monosilicide to cobalt disilicide ( $\text{CoSi}_2$ ) by a third-stage heat treatment in which the silicon wafer is heated at a temperature higher than the temperature of the second-stage heat treatment.

9. A fabrication method of a semiconductor integrated circuit device according to Claim 8,

wherein the deposition temperature of the cobalt film in the step (a) is less than  $200^\circ\text{C}$ .

10. A fabrication method of a semiconductor integrated circuit device according to Claim 9,

wherein the deposition temperature of the cobalt film in the step (a) is less than  $100^\circ\text{C}$ .

11. A fabrication method of a semiconductor integrated circuit device according to Claim 10,

wherein the deposition temperature of the cobalt film in the step (a) is less than  $50^\circ\text{C}$ .

12. A fabrication method of a semiconductor integrated circuit device according to Claim 8,

wherein the temperature of the first-stage heat

treatment in the step (c) is equal to the deposition temperature of the oxidation barrier film in the step (b).

13. A fabrication method of a semiconductor integrated circuit device according to Claim 8,

wherein the temperature of the first-stage heat treatment in the step (c) falls within a range of 200°C or greater but less than 400°C.

14. A fabrication method of a semiconductor integrated circuit device according to Claim 8,

wherein the temperature of the second-stage heat treatment in the step (d) falls within a range of 400°C or greater but less than 700°C.

15. A fabrication method of a semiconductor integrated circuit device according to Claim 8,

wherein the temperature of the third-stage heat treatment in the step (f) falls within a range of 700°C or greater but less than 900°C.

16. A fabrication method of a semiconductor integrated circuit device according to Claim 8,

wherein the deposition time of the cobalt film in the step (a) and the deposition time of the oxidation barrier film in the step (b) are each less than 15 seconds.

17. A fabrication method of a semiconductor integrated circuit device, comprising the steps of:

(a) forming a MISFET having a source and a drain made

of a pair of semiconductor regions formed over the main surface of a silicon substrate, a gate insulating film formed over the main surface of the silicon substrate, and a gate electrode formed over the gate insulating film;

(b) depositing a cobalt film over the main surface of the silicon substrate having the MISFET formed thereover at a temperature lower than the temperature at which a reaction layer between silicon and cobalt is formed over the surface of the semiconductor regions constituting the source and drain;

(c) depositing an oxidation barrier film over the cobalt film;

(d) forming a silicide layer having, as a main component, dicobalt silicide ( $\text{Co}_2\text{Si}$ ) over the surface of the semiconductor regions constituting the source and drain by heat treating the silicon substrate having the cobalt film and oxidation barrier film deposited thereover at a first temperature;

(e) converting the main component of the silicide layer from dicobalt silicide to cobalt monosilicide ( $\text{CoSi}$ ) by heat treating the silicon substrate at a second temperature higher than the first temperature;

(f) after the step (e), removing the oxidation barrier film and an unreacted portion of the cobalt film from the main surface of the silicon substrate; and

(g) after the step (f), converting the main component of the silicide layer from cobalt monosilicide to cobalt disilicide ( $\text{CoSi}_2$ ) by heat treating the silicon substrate at a third temperature higher than the second temperature.

18. A fabrication method of a semiconductor integrated circuit device according to Claim 17,

wherein the deposition temperature of the cobalt film is less than  $200^\circ\text{C}$ , preferably less than  $100^\circ\text{C}$ , more preferably less than  $50^\circ\text{C}$ .

19. A fabrication method of a semiconductor integrated circuit device according to Claim 18,

wherein the first temperature falls within a range of  $200^\circ\text{C}$  or greater but less than  $400^\circ\text{C}$ , the second temperature falls within a range of  $400^\circ\text{C}$  or greater but less than  $700^\circ\text{C}$ , and the third temperature falls within a range of  $700^\circ\text{C}$  or greater but less than  $900^\circ\text{C}$ .